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Indonesian quarter-rudder mountings

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Ten quarter-rudder arrangements found in Indonesia are described and illustrated with evidence for an 11th arrangement. Some types have been used on vessels of over 100 tons, while others occur on offshore fishing craft and outrigger canoes. The ethno-archaeological evidence gathered in the field is used as a basis for consideration of quarter-rudders used in the Classical and Medieval Mediterranean. © 2000 The Nautical Archaeology Society

Key words: Indonesia, *prahu/perahu*, maritime technology, steering gear.

Introduction

This paper details ten quarter-rudder mounting arrangements that are to be found in Indonesia, or were until very recently. Some types have been used on vessels of over 100 tonnes capacity, other are used on offshore fishing craft and some are from outrigger canoes. Iconographic evidence for an 11th arrangement is discussed. Two non-pintle and gudgeon arrangements of median rudders and unusual tiller arrangements are also described.

Most of the data are personal observations collected on numerous visits to Indonesia between 1975 and 1996 including sailing trips on vessels with quarter-rudders. The writing of this paper was stimulated by Mott's (1997) major work on the development of the rudder. Mott stated that the rudder is the one mechanism that all ships have in common, and that the quarter-mounted rudder was highly developed by 2,500 BCE and was the standard arrangement for nearly 4,000 years. The sternpost mounted, or median, rudder's replacement of the quarter-rudder occurred for complex reasons (Mott, 1997: 3). That replacement is not complete: quarter-rudders are still used widely in Indonesia, on a range of fishing craft, and on some timber-hulled cargo carriers of more than 100 tonnes capacity including motorized vessels.

Mott recognized that quarter-rudders remain in use in Southeast Asia, but only discussed one Indonesian mounting arrangement and considered it in the context of his analysis of Classical and Medieval Mediterranean quarter-rudders. An alternative approach is to look first at the ethno-archaeology available in Indonesia and use that as a basis for the consideration of quarter-rudders used in the past. From the Indonesian evidence of quarter-rudder mounting arrangements, it is argued that Mott may have over-emphasized the need for approximately neutral buoyancy in the deployment of a quarter-rudder, and unnecessarily assumed that quarter-rudders were usually held by simple lashings at two points.

Main types of mounting

Indonesian quarter-rudder arrangements may be considered in two broad groups:

- group 1: two (port and starboard) rudders can be deployed simultaneously;
- group 2: only one rudder is used.

Group 2 can be sub-divided into three: 2(a), where the windward rudder is normally lifted out of the water and the (newly) lee rudder lowered every time the vessel changes tack—this type can be seen as intermediate between groups 1 and 2; 2(b), where the rudder is always carried on the same quarter (port quarter); and 2(c), where the rudder is shifted around the stern to the lee side every time the vessel changes tack.

With group 1, the windward rudder is not always manned and it can be taken out of the water when under way. Group 1 mountings on

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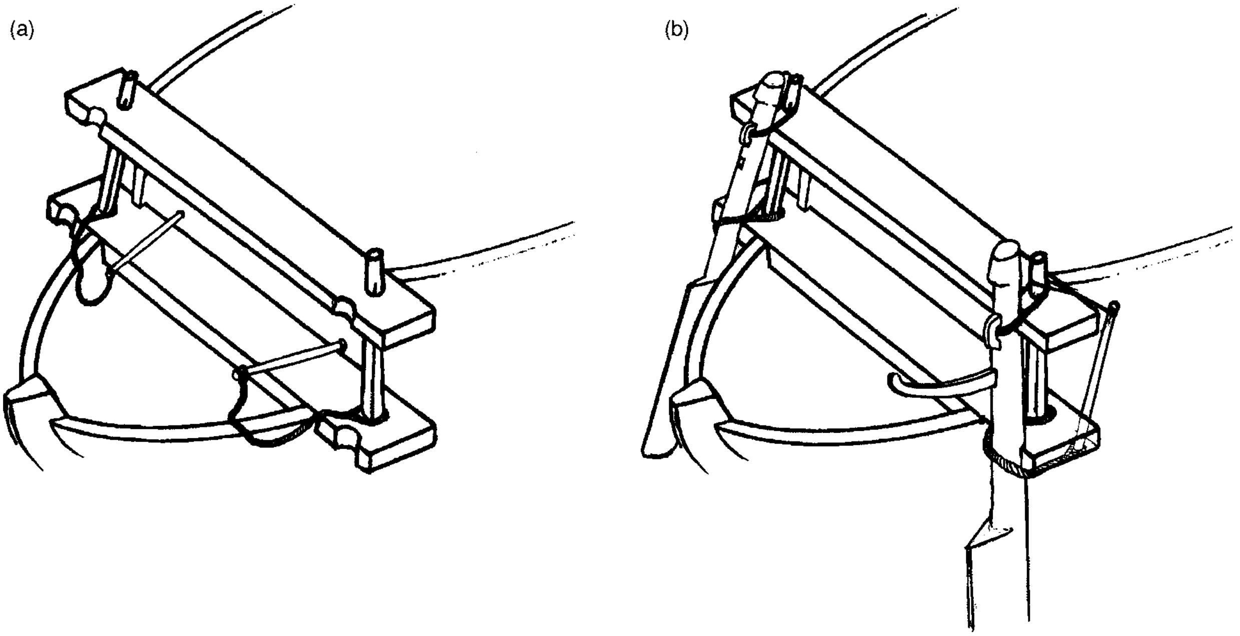

Figure 1. Eastern Indonesian rudder mounting with (a) rudders removed and (b) rudders in place. (Drawing: author)

small craft are sometimes used with only one rudder is if they were group 2(c) mountings.

In general, group 1 are found in Eastern Indonesia while group 2 are from Java and neighbouring islands. Group 1 usually have aft-pointing tillers while group 2 almost always have forward-pointing tillers. Very strong, high density timbers, particularly *Vitex pubescens* and *Vitex gofassus*, are used in constructing rudder mountings, and also to make the rudders.

Basic Eastern Indonesian mounting

This type is found on a broad range of small craft, up to about 10 m in length, built in Eastern Indonesia, particularly South Sulawesi and neighbouring islands. It is an 'aft mounting' in Mott's (1997: 25) scheme of quarter-rudder mounting classification. The type is well illustrated in Horridge (1979: 21).

There are two rudder mounting beams or thwarts. The lower one (called *sangkilang*, or a cognate name, in most places) is usually larger and slightly further aft than the upper one. The rudder stock fits into notches carved into the aft faces of both beams. A sturdy hardwood post passes through the upper beam and is tenoned deeply into the lower beam immediately forward of the notches into which the rudder fits (Fig. 1). The head of the rudder is stropped to the top of that post. The strop, which is usually a Turks head sennit, is so devised that it can easily be slipped over the post when the rudder is in a raised position, but becomes very tight when the rudder is lowered into its deployed position (Fig. 2).

A second strop of much thicker rope (or material such as rattan or car tyre) is attached to the post where it is tenoned into the lower beam. At its other end is a sturdy hardwood pin. The length of the strop is such that the strop can be taken around the rudder stock and forward under the mounting beam and the pin can then be used as a lever, with its fulcrum on the forward face of

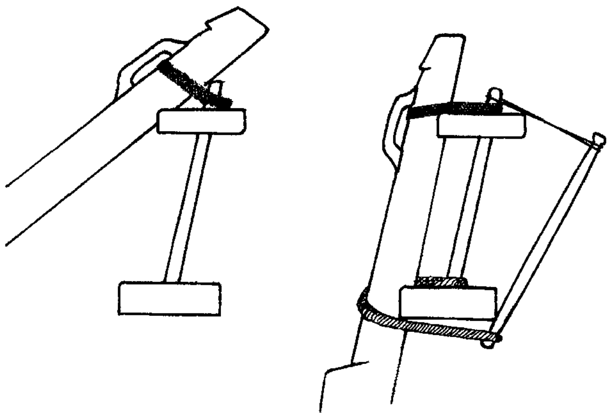

Figure 2. The head strop tightens when the rudder is lowered into position. (Drawing: author)

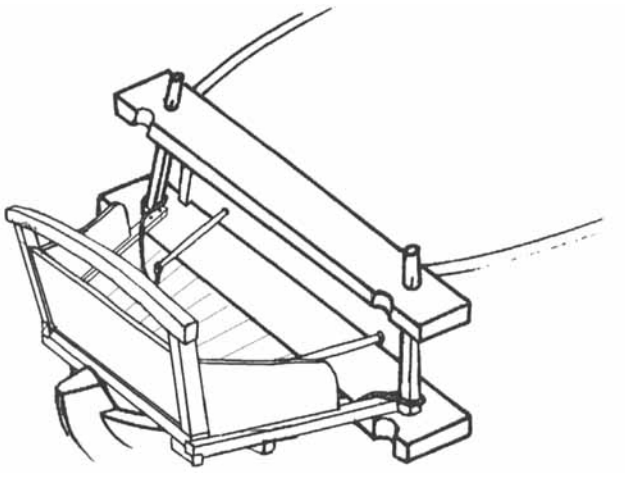

Figure 3. Timbers to prevent the rudder being forced inboard form the rail of a stern gallery. (Drawing: author)

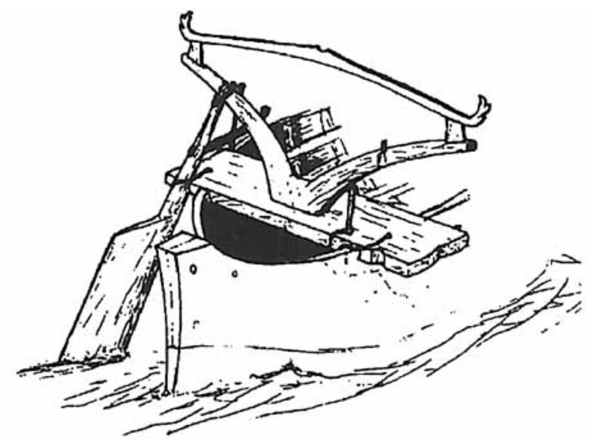

Figure 4. A 'Y-beam' version of the Eastern Indonesian rudder mounting. (Drawing: author)

the mounting beam, to tighten the strop around the rudder stock. A lanyard lashes the top of the pin to the top of the post. This lanyard is held ready to be cast-off when sailing in shallow water and it is a relatively light line intended to break and release the rudder in the event of accidental grounding. Alternatively the pin should break before the rudder, but it is usually an ironwood such as *Eusideroxylon zwagerii.*

The rudder stock is deeply socketed into the after face of the lower mounting beam, and must be lashed very firmly in place using the lever-pin and strop. The rudder is usually very stiff to turn because of the tight lashing. For small craft the system is adequate, but when sailing fast, particularly reaching or going to windward, or when manoeuvring, lateral forces and drag on the rudder are great and there is some tendency for the rudder stock to be forced out of its notch in the lower beam. The weather rudder is often taken out of the water. The lee rudder can be forced inwards under the stern by the lateral forces from the sails that cause leeway. In all but the smallest mono-hull craft, a timber runs aft from the lower rudder mounting beam inboard of the rudder to prevent this. Often this timber is part of a gallery, called an *ambeng*, built over the stern (Fig. 3). Outrigger canoes, which have very deep hulls and make less leeway, are less likely to have that timber, and most have the rudder mounting too far aft for such a timber to be fitted. A functionally very similar type of rudder mounting has a forked timber, or two crooked timbers, or similar arrangement, in place of the straight upper mounting beam. This type allows the lower beam to be at the height of the rail and is often used with a forward-pointing tiller (Figs 4 & 5).

Rudder shapes vary regionally and also vary with the size of vessel. Some small vessels use the very high aspect ratio rudders with thick foil

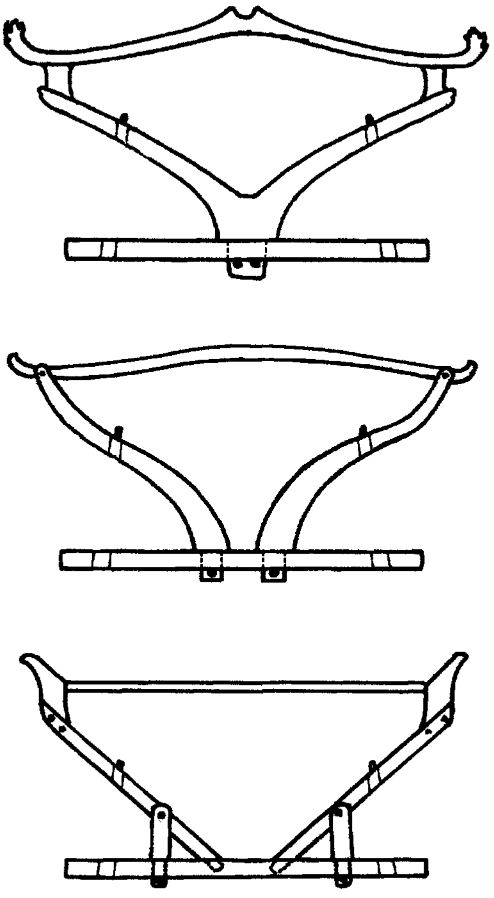

Figure 5. Three of the structures used in constructing 'Y' mountings.

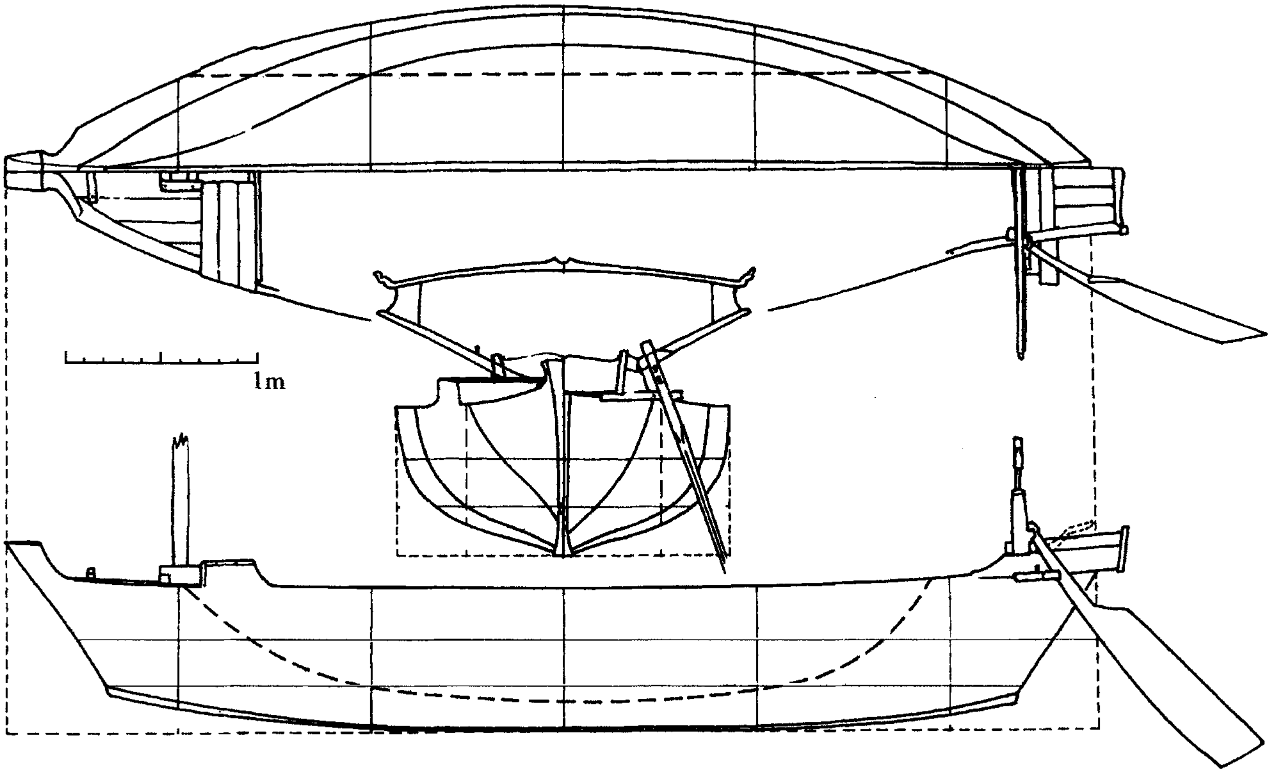

Figure 6. The *juko* from Ende, Flores, has a relatively low aspect ratio rudder raked strongly aft. (Drawing: author)

section that are used on most larger craft. Others use lower aspect ratio shapes and relatively thinner blades. Probably all rudder blades have a narrow squared-off after edge. Angle of rake also varies. In general the thick-bladed high aspect ratio type is used nearly upright while other shapes are more likely to be sharply raked aft (Fig. 6). Seen from ahead or astern the rudders angle or splay outwards so that the lee rudder comes to vertical as the vessel heels. This angle of splay varies according to regional and local design precepts, and is only slight in outrigger craft that do not heel much (Fig. 7). Craft that use this simple type of Eastern Indonesian rudder mounting include: double and single outrigger canoes; small shallow-drafted cargo vessels; sea-going vessels called *perahu patorani* that use traps to collect flying fish roe; and the deep and sharp-lined *sope*—the vessels of the Bajo 'sea-gipsy' people. The type is sometimes used for auxiliary rudders on large vessels which also carry a median, sternpost-mounted rudder.

Palari-pinis type

This type is the version of the basic Eastern Indonesian mounting for larger vessels. In South Sulawesi and surrounding regions, traditional sea-going vessels from about 9 m in length up to the largest of the *perahu pinis* (about 400 tonnes built in the 1970s) have this type of quarter-rudder mounting. The addition of a timber running aft from the lower mounting beam outboard of the rudder prevents it from being forced out of its notch on the aft face of the beam, particularly when the rudder is on the windward side and being forced outboard by leeway. This timber is lashed in place when the rudder is deployed (Fig. 8) and can be cast-off to allow the rudder to be swung up out of the water and removed. It also allows the rudder to be operated in a partly raised position when sailing in shallow water, but this is not done for extended periods of time. Mott (1997: 90) proposed that the rudder is partly raised when sailing deep laden to achieve equilibrium buoyancy. This seems unlikely because many rudders are made from timber that does not float: *Vitex pubescens, Intsia bijuga* and *Eusideron Zwagerii* are commonly used and all have densities greater than sea-water. Hawkins (1982: 81) proposed that the rudders would have neutral buoyancy in the normal deployed position when laden if made from teak (*Tectona grandis*). However, large teak baulks are rarely available to

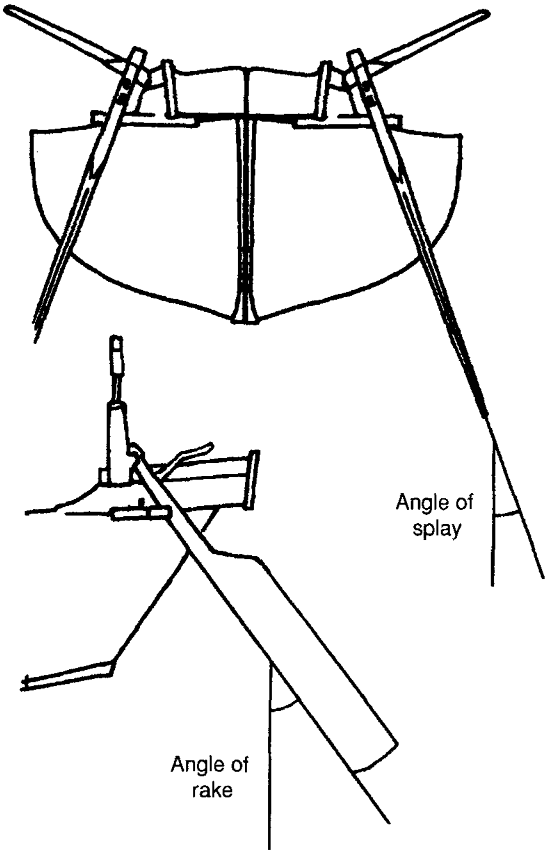

Figure 7. Angle of rudder rake and angle of splay. (Drawing: author)

South Sulawesi shipbuilders, and teak rudders are not standard. Rudders are sometimes deployed angled aft to relieve weather helm by bringing the centre of lateral resistance further aft.

The palari-pinis rudder always has a high aspect ratio and usually has a thick foil shape in cross-section; this is particularly true of the rudders of large *perahu pinis*. The foil shape tapers down to a thinner foil towards the bottom end of the rudder.

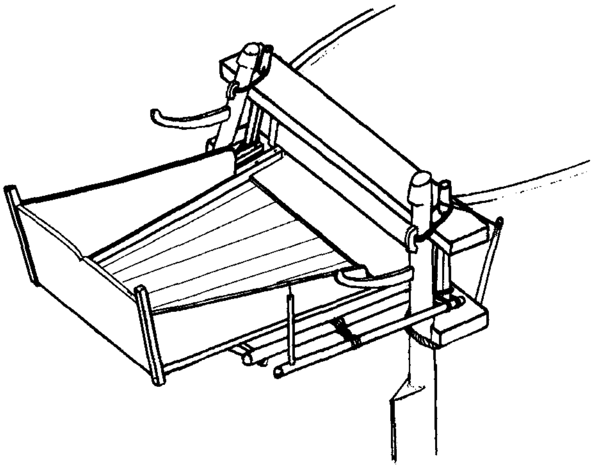

Figure 8. The palari-pinis rudder mounting. (Drawing: author)

On *perahu pinis*, rudder tackles are rigged from the mizen hounds to the rudder heads. They are used to hoist the rudder to a point where it pivots on the upper mounting beam so that the head can be swung forward as the tackle is slacked away until the rudder is brought horizontal. With a line passed around the rudder blade it can then be slid aft in the raised position ready to be lowered for redeployment (Fig. 9).

This type of rudder is used on South Sulawesi craft called *perahu palari*, *perahu bago*, *perahu jengki*, and *perahu pinis* (or *pinisi*) which all have a similar hull form but different range of size and different rigs. They are also used on *perahu calabai* and *perahu lambo-pinis* which have a different type of hull form, and on *perahu layar motor* (auxiliary motor *perahu*) of various hull forms. The palari-pinis rudder has also been adopted on

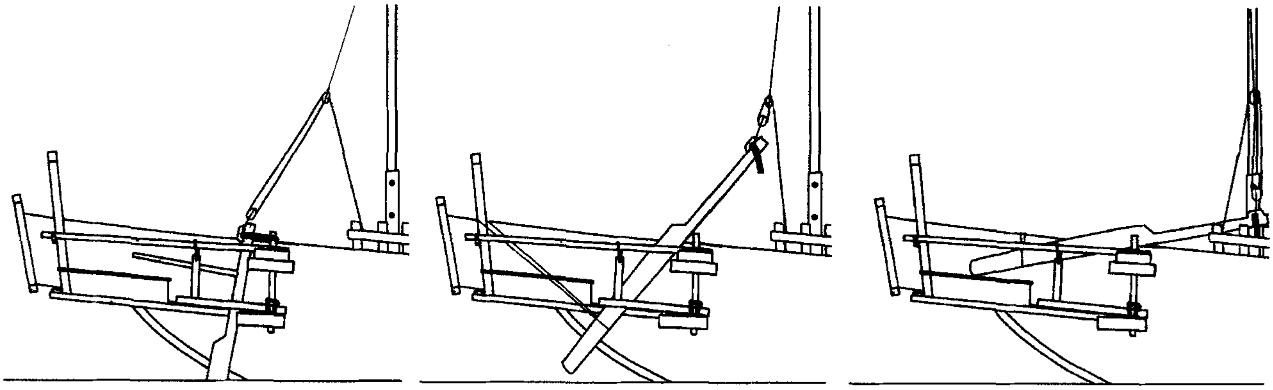

Figure 9. Use of the rudder tackle on a *perahu pinis*. (Drawing: author)

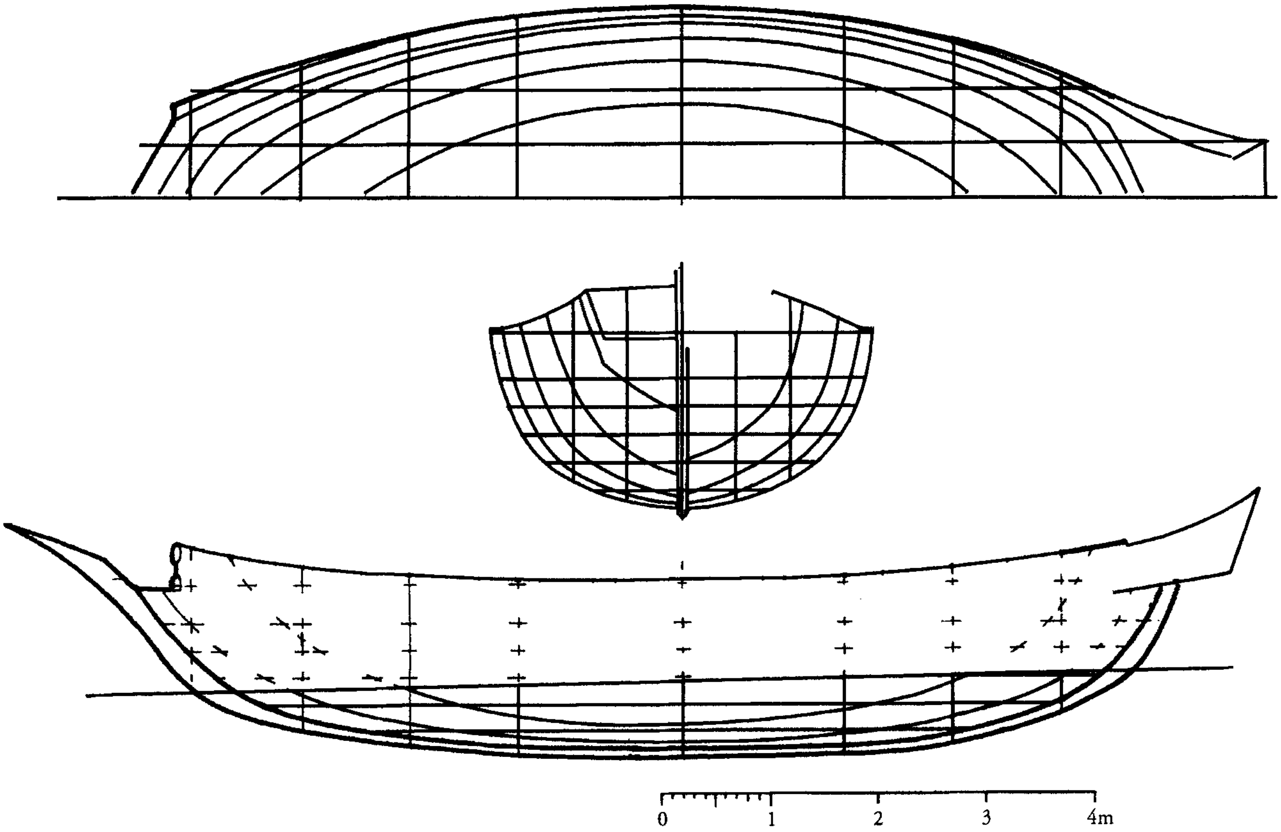

Figure 10. Lines of the *perahu patorani* named *Sinar Galesong.* (Drawing: author)

some very large Madurese *perahu* in recent years. Traditionally these vessels have different rudder mountings described below. The convenience of not needing to hoist the windward side rudder out of the water, or shift it to leeward, every time the vessel changes tack is the reason for this adoption of foreign technology. It is accepted that some loss of lateral resistance and windward ability is entailed in adopting the relatively small bladed palari-pinis double rudders. One large rudder better counters leeway than two smaller rudders even when the resultant centre of lateral resistance is the same.

The retention of quarter-rudders on *perahu pinis*, and even on auxiliary motor ships, is curious. A number of advantages are cited by Indonesian sailors. Quarter rudders are easily removed and therefore are not damaged when operating from harbours, creeks or beaches that dry out at low tide, or in accidental grounding. They are low-tech and require no metal parts. With the quarter-rudders raised, a vessel behaves better at anchor, it is less likely to sheer around, because the centre of lateral resistance moves forward and the vessel lies quietly head to wind. Quarter rudders are said to require less work on the part of the helmsman than a median rudder when sailing a straight course. Because the rudder is stiff in its lashings, the tiller does not have to be held to stop the rudder from turning and only needs to be adjusted slightly from time to time when sailing a steady course. The *parlari-pinis* hull form has a curved sternpost that is not suitable for mounting a pintle-and-gudgeon rudder. There are large Indonesian *perahu* that use median pintle-and-gudgeon rudders: the counter-sterned *perahu lambo* have the rudder stock of their median rudder passing through the counter stern inside a rudder trunk which is a tube hollowed out of a tree trunk. Making the rudder trunk for a large *perahu* by hand is a great deal of work.

There are two types of double-ended *lambo*, which do not require a rudder trunk, and were sometimes fitted with quarter-rudders: Balinese *lambo* from Benoa and Bajo *lambo* from Mola used for fishing and turtle hunting, which involved lying adrift in the open sea, fitted quarter-rudders that could be raised when lying adrift. This left the aft deck uncluttered by a tiller

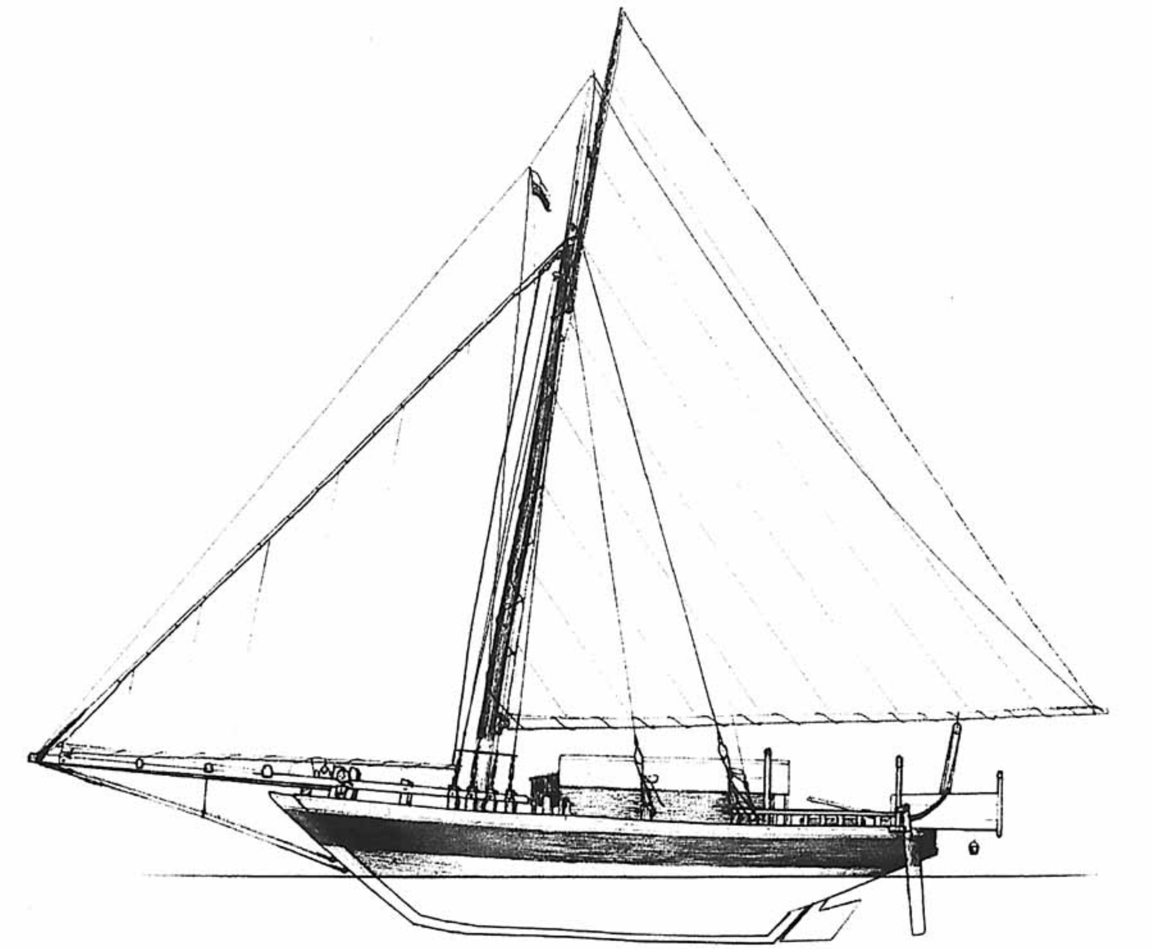

Figure 11. The short sternpost on some types of *perahu lambo*, such as the Jampea *lambo*, cannot mount an effective rudder. Either auxiliary quarter-rudders are fitted, or large quarter-rudders are fitted and the median rudder dispensed with. (Drawing: author)

which would have had to be lashed to stop the median rudder slamming to and fro.

There is a perception that quarter-rudder steered *perahu* do not tack as easily as median-rudder steered perahu. In general this is clearly true, but the problem is probably more a question of hull form than rudder effectiveness. Most *perahu* of the *palari-pinis* type have little deadrise, fairly bluff ends and little lateral resistance in the forefoot and heel (Fig. 10). They sail to windward poorly: they cannot lie close to the wind and they make a lot of leeway with the hull always on the verge of stalling. When the helm is put down to tack, the heading of the ship changes but the hull tends to keep moving in the same direction, increasingly going sideways with the hull completely stalled, so it loses way and cannot be sailed round onto the new tack. These vessels have to be levered around by backing sails even when sailing in smooth water. By comparison, *perahu lambo* have greater deadrise, sharper ends and much more lateral resistance created by the sharp forefoot and heel (Figs 24 & 25), so they sail closer to the wind and make less leeway. They tack more quickly and sometimes without backing sails if not stopped by a head sea. Some sharp double-ended *lambo* or *lambo-soppe* were steered with quarter-rudders and tacked quite efficiently.

Some counter-sterned *lambo* and *lambo-pinis* are quarter-rudder steered, but these are always shallow drafted vessels with too short a sternpost for an effective median rudder to be fitted (Fig. 11).

The Bali Jukung type

Jukung are fast double outrigger canoes from the south and east coasts of Bali (Fig. 12). They are

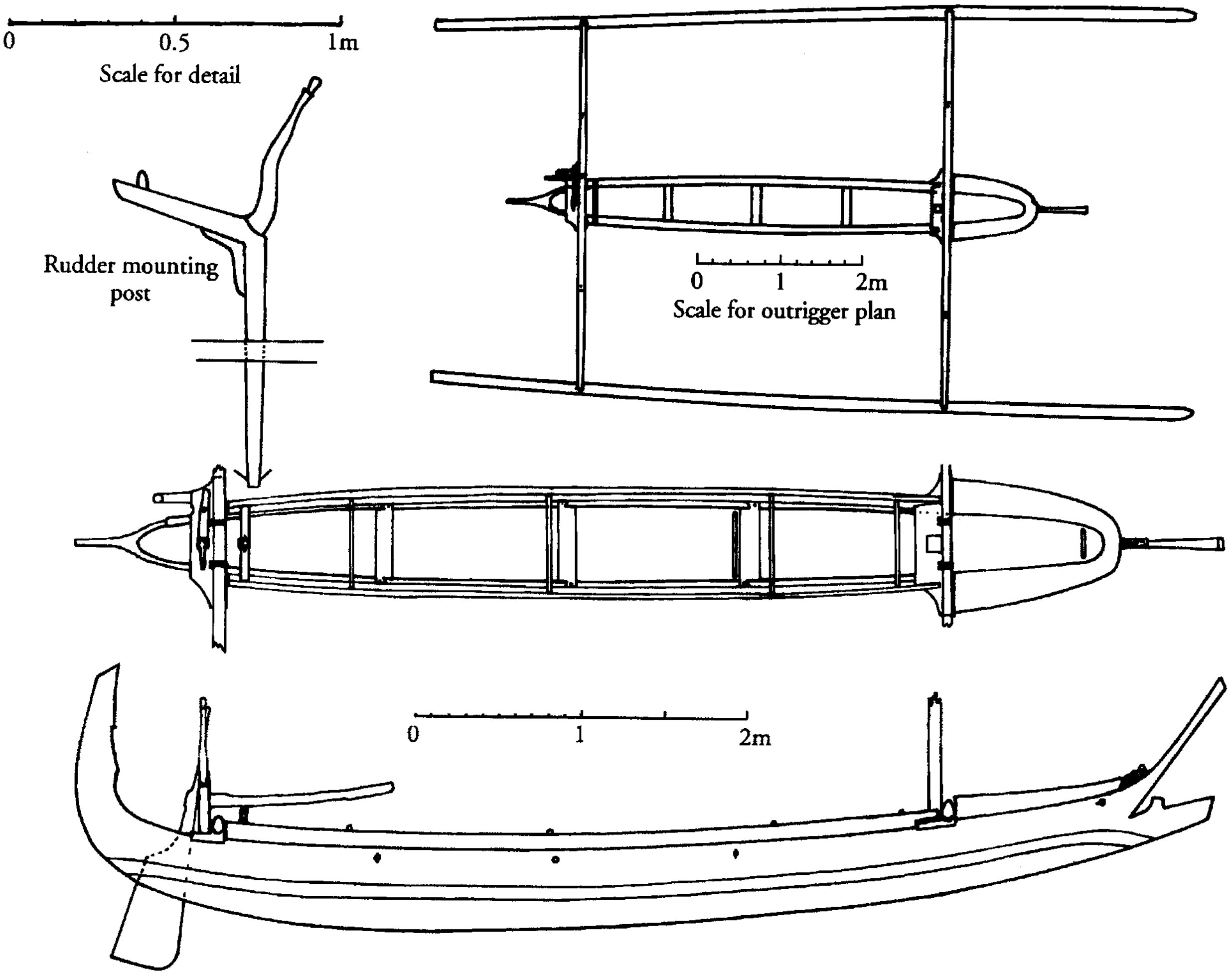

Figure 12. A Balinese *jukung* from Tanjung Benoa (now in the collection of the Northern Territory Museum of Arts and Sciences, Darwin, Australia). (Drawing: author)

built in three distinct styles: all carry their rudder on the port quarter. There is iconographic evidence that some outrigger canoes from neighbouring Madura island also carried a single rudder to port in the past. However, photographs and models of Madurese canoes, and the author's experience, offer no confirmation of this. The Bali *jukung* arrangement can be seen as one half of the basic eastern Indonesian arrangement or a modification of Javanese types. The rudder stock is very nearly vertical and the slightly foil-shaped blade is large relative to the size of the canoe. The post which the rudder depends from is usually made from very tough mangrove timber and is stepped through a heavy thwart into a step like a mast-step. Outboard of the rudder a timber projects aft from the mounting beam to prevent the rudder from splaying outwards. Performance is not noticeably worse on port tack when the rudder is carried to windward.

One type of outrigger canoe from north-west Lombok also carries its rudder to port. This type is associated with the Bajo and Bugis (Sulawesi) people of the area, not with the Balinese people, and it might be the origin of the *jukung* type. The type was recorded by Nieuwenkamp in 1904 (Nieuwenkamp, 1926: 177) and an example was seen, apparently identical in design, in 1985.

Madurese Janggolan type

Janggolan are a particular type of cargo *perahu* from a short stretch of the south coast of Madura, a large island off the north-east coast of Java (Fig. 13). The janggolan rudder mounting can be seen as intermediate between the Eastern Indonesian types and the Javanese types.

The traditional vessels of Java and Madura are mostly steered with a single rudder that is carried

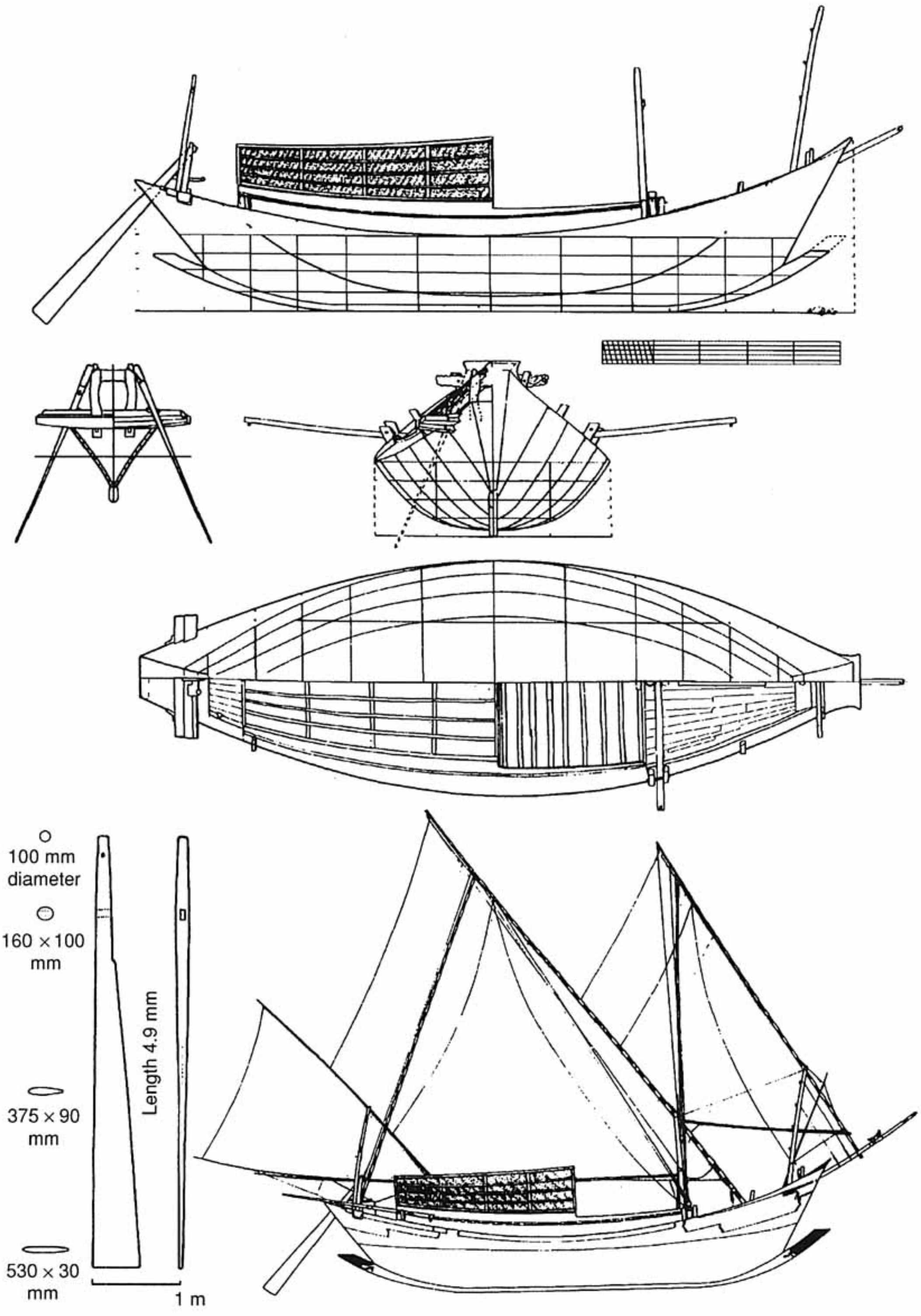

Figure 13. A Madurese *janggolan* '*Uranya*', lines, sail plan and rudder details. (Drawing: author).

on the lee quarter of the hull and has to be shifted around the stern to the new lee quarter whenever the vessel changes tack. The typical Javanese rudder is lashed against a heavy fore-and-aft rail timber in the stern and depends from a central post stepped through a thwart in the stern (Fig. 14).

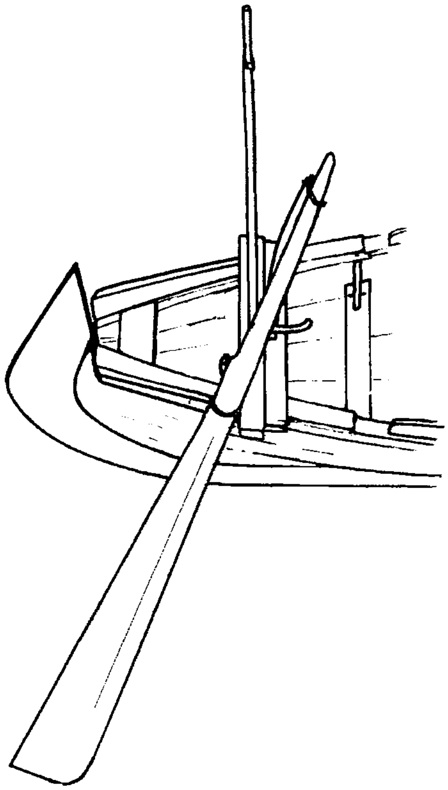

Figure 14. Typical Javanese quarter-rudder mounting on a *perahu mayang*. (Drawing: author)

The *janggolan* combines features of Eastern and Javanese systems. There are two rudders—port and starboard rudders—but the windward rudder is generally raised out of the water and could not be carried in fresh conditions. The two rudders can be deployed simultaneously when running before the wind, when making short tacks, or in fluky conditions when raising and lowering the heavy rudders in response to every change in wind would be arduous. But the two rudders employed simultaneously create significant lee helm and drag which is detrimental to performance especially when sailing to windward. The large and high aspect-ratio rudder blades of *janggolan* (and all traditional Madurese *perahu*) are very important for resisting leeway, the centre of effort of the sail plan is well aft, almost over the rudder, because the hull form provides very little lateral resistance (Fig. 15).

Madurese rudders (including those of the *janggolan*) differ significantly from the Eastern types. They are located slightly further aft on the hull. They are splayed outwards more—about 15° in the case of the *janggolan*—and some are semi-balanced rudders with part of the blade forward of their axis of rotation. Typically, Madurese and Javanese rudders are triangular in shape, tapering from bottom to top so there is no clear division between stock and blade. The cross-sectional shape is sharper and thinner than Sulawesi rudders.

The rudders of Javanese *mayang* (seine-net fishing vessels) and most types of Madurese *perahu* depend from a single post stepped through a thwart in the tern, but the two rudders of a *janggolan* depend from two linked posts stepped in the stern, which form an H-shaped structure known as *tetongkul* or *kultongkul*. The rudders are lashed against both the aft face of a projecting beam (*dapuran* meaning the 'shoulders', or *pengkalang* 'a thwart') and against a heavy rail timber (*pegepe*).

The rudders of a 15 m long *janggolan* are nearly 5 m in length: this is a defined design proportion, equal to one-third the length and therefore equal to the beam of the vessel. The rudders are fashioned from massive baulks of hardwood. Long grained heavy timbers, *Eusideroxylon zwagerii* and *Intsia bijuga*, are the timbers favoured for their strength, but the rudders made from these timbers are heavy and it takes three well-co-ordinated men (the entire crew of a 40 tonne short haul *janggolan*) to raise or lower a rudder.

To raise a rudder, the head is pivoted forward slightly to relieve the load on the head strop so that the strop can be taken off the mounting post. The head is then pivoted further forward bringing it nearly horizontal so that the rudder can be slid forward till the head lies inboard of a projecting timber at the aft end of the deck-house. The lashing that passes around the stock where it bears against the rudder-mounting beam and *pengepe* is not cast off. It goes slack when the rudder head is pivoted forward. Unlike all other Indonesian *perahu* with boomed lateen rigs, *janggolan* can tack but usually they wear round when changing tack at sea or in a fresh breeze.[1]

The largest *janggolan*, which are a recent development for the West Java timber trade, now employ the more convenient palari-pinis double rudders because janggolan-type rudders of adequate proportions for these vessels would be dangerously heavy and unwieldy for the crew to shift at sea.[2] *Janggolan* that have the double thwarts for mounting palari-pinis type rudders built into their stern are called *spelen*. *Spelen* do not have the rudder mounting posts stepped in the stern and therefore can have a small deck-house built on it, like South Sulawesi *perahu pinis*. This

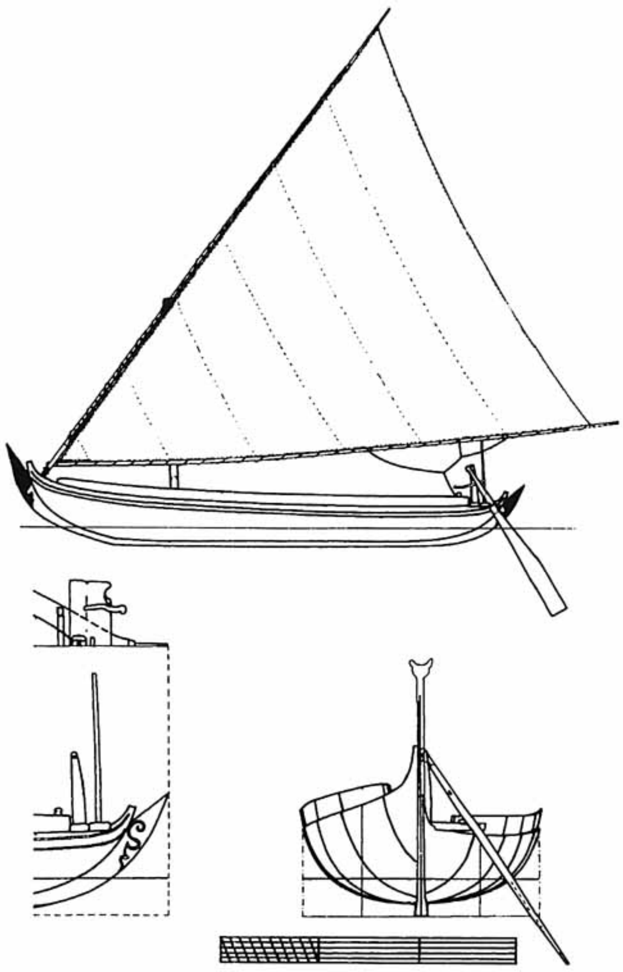

Figure 15. Detail of a small Madurese *perahu lete lete* or *pakesan 'Semanis'*. Collection of the Northern Territory Museum of Arts and Sciences, Darwin, Australia. (Drawing: author)

gives the timber-carriers, which spend at least 8 months of the year away trading, a greater degree of crew comfort than the traditional *janggolan*, in which the accommodation is a cramped hutch at the extreme aft end of the deckhouse gable.

Lete lete type

Perahu lete lete are the main cargo-carrying vessel of eastern Madura and islands to the east of Madura—Raas, Sapudi and the Kangean Group (Figs 15–18). There are local variations in design.

The *lete lete* rudder depends from a single post stepped through the rudder mounting beam. It fits into a notch on the after face of the rudder mounting beam and in some cases it bears on a timber that runs aft from the beam on the inboard side of the rudder. The rudder mounting beam is well aft—usually right up against the sternpost. A lashing passes around the rudder stock but it is not tightened with a lever and sometimes is only moderately tight. To set it tightly it is tied off with the rudder lying near horizontal, before the rudder is brought into the upright position with the head stropped to the mounting post. The *lete lete* rig has a sail plan centre of effort well aft creating weather helm so that the vessel always leans on its rudder or, to put it another way, the rudder always pushes inboard. The notch in the aft face of the beam does not have to be as deep as in the Eastern Indonesian type if a timber running aft from the beam is fitted. However, *lete lete* from Gilli Genteng, which can be very large, do not have that timber fitted.

When *lete lete* change tack the rudder is unstropped and shifted around the sternpost to the new lee side. Shifting the rudder around the stern when changing the tack is said to be difficult and dangerous in a seaway. There is usually a light line from the rudder blade made fast to the stern for retrieving the rudder should it get out of control. The *janggolan* technique of raising the windward rudder and lowering the leeward rudder is not used although a spare rudder is usually carried on a *lete lete*.

Rudder shape varies with location. *Lete lete* rudders from islands closest to Madura, principally Gilli Genteng, are similar to *janggolan* rudders. Rudders from the Kangean group which is further east have a distinct stock and blade like Sulawesi rudders but, in the Java/Madura style, they widen towards the bottom rather than taper. The *jegongan*, a large *mayang* fishing vessel from West Java, uses the same type of rudder mounting.

Golekan type

The *golekan* is the main cargo *perahu* from the north-west coast of Madura. It is stylistically similar to the *lete lete*. The rudder mounting is similar but the rudder mounting beam is not so far aft and, rather than a flat thwart, it is approximately square in section and tapered towards the outboard ends. There is little or no notch to accommodate the rudder on the after face. The post from which the rudder depends is different in shape; it is broader and more strongly bifid.

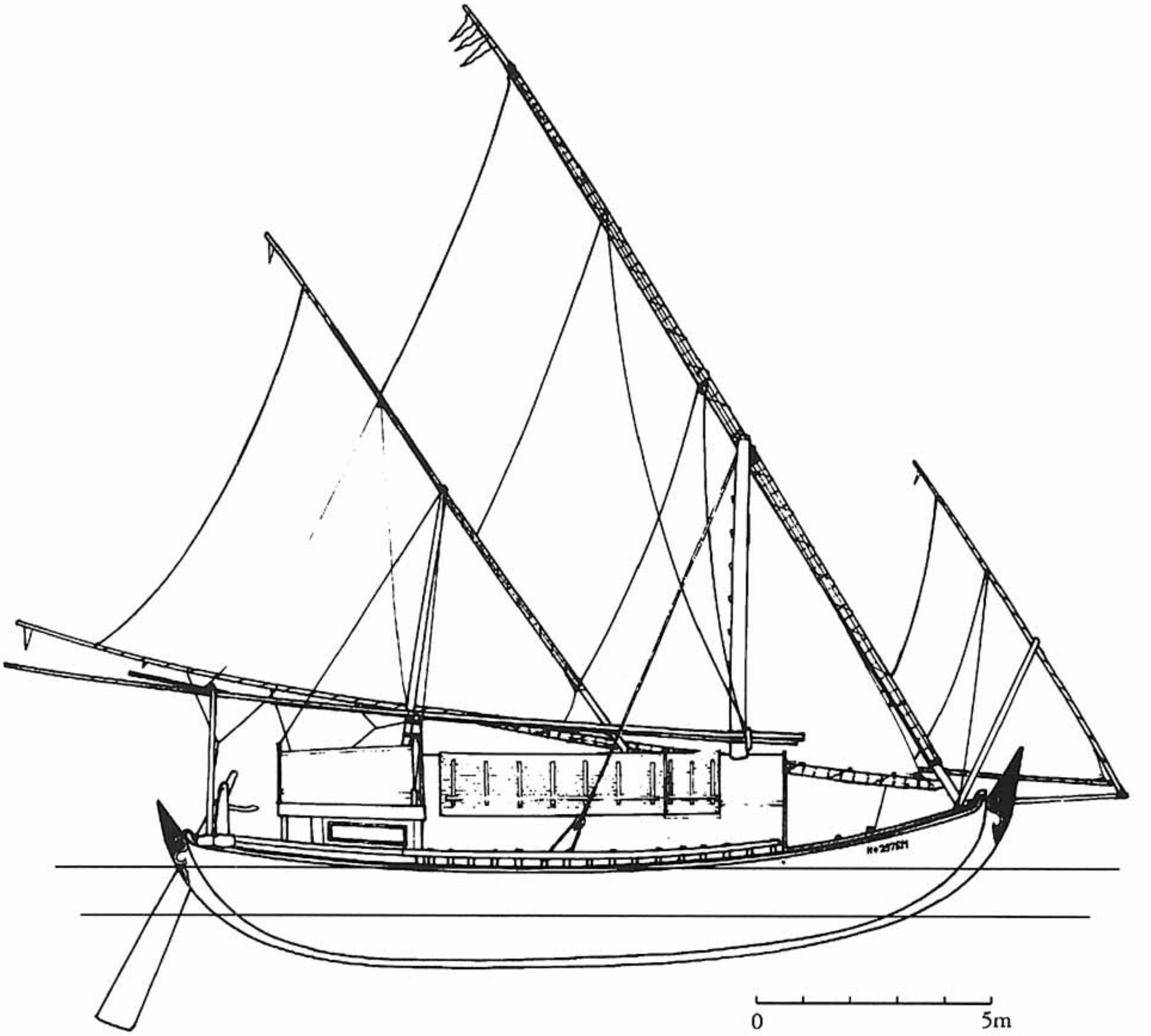

Figure 16. A *perahu lete lete* from Gilli Genteng, Madura showing approximate light and deep laden waterlines. (Drawing: author)

Running aft from the beam are rail timbers which the rudder bears against (Fig. 19).

The shape of the *golekan* rudder is distinctive, widening from top to bottom and flaring out at the bottom. The rudder, when deployed, splays widely but does not rake aft very much. Like a *lete lete* rudder, it is shifted around the stern when changing tack. Fishing vessels such as *perahu antokan* on the north coast of Madura have the same rudder mounting.

A similar arrangement is used on the *lete lete*-styled *perahu kelulis* from the small islands on the western side of the Kei group in the far east of Indonesia, but, typical of Eastern Indonesia, the Kei tiller points aft.

Kacik type

Kacik were medium-sized cargo and passenger vessels from the south coast of Madura. *Perahu kacik* were highly decorated and exotic looking vessels. Unusually for Javanese vessels, there is no separate post from which the rudder depends. Instead it depends from one of two pegs, just off centre, port and starboard, on a strongly reinforced frame at the aft end of the deck-house. The spar crutch post which is usually stepped immediately abaft the rudder mounting post is immediately abaft this frame. The spar crutch post steps through a beam which has ends that project outboard three of four strakes below the rail. A

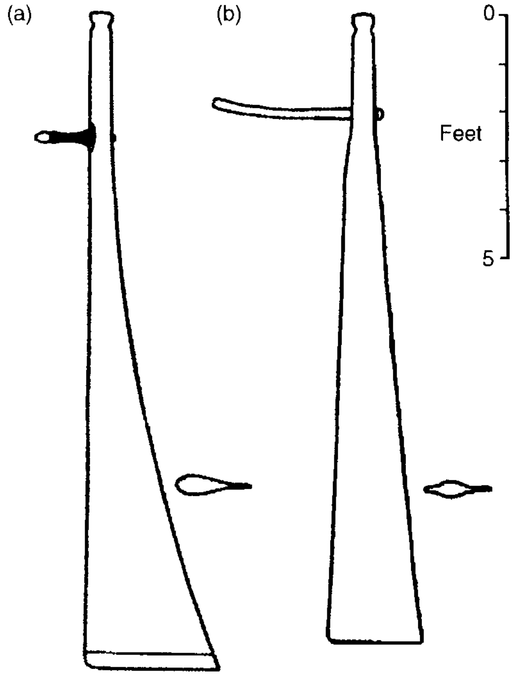

Figure 17. Rudders of *golekan* (a) and *lete lete* (b) from Gibson-Hill (1950). (Drawing: author)

second beam projects at the height of the rail and somewhat aft of the lower one. These beams look like rudder mounting beams, but they are not used for rudder mounting. There are timbers (called *sengkir*) with upturned ends that project outboard and obliquely aft from the upper beam on either side, and the rudder when deployed fits into the angle between these timbers and the edge of a small platform built on the stern (Fig. 20). Neither the *sengkir* nor rail are much shaped to create a smooth notch to accommodate the rudder.

The rudder is shaped rather like that of the *golekan* but is less flared at the foot. The last *kacik* sailed in the early 1980s. They were particularly elegant craft, well built, and much effort was lavished on the polychrome carving that decorated them, but their rudder-mounting arrangement is curious and features of it suggest that it had changed in fairly recent times. Paris (1841) and Reith (1992) showed a similar Javanese vessel with the same arrangement for stropping the head of the rudder but the stock seems to bear against a projecting beam rather than a *sengkir*.

A similar arrangement is used on *mayang* fishing craft from the Java shore of Madura strait, opposite the home of the *kacik*. The fishing boats, called *jangraja*, have the usual rudder mounting post, and have the obliquely projecting timber (*sengkir*) only on the starboard side. *Jangraja* always shoot the *payang* (seine net) over the port side. Motorized *jangraja* cannot carry their quarter-rudder to port. It is presumed that a temporary *sengkir* was used on the port side when *jangraja* sailed since a related type of fishing vessel, the *kolek* (see below), uses temporary *sengkir* (called *mangga mangga* in West Java) on both sides if it sails but has a fixed *mangga mangga* to starboard if motorized. Another type of fishing boat, called *seroto*, from West Java, uses permanent *mangga mangga*, port and starboard.

Cemplok type

Cemplok are cargo vessels of up to about 80 tonnes burden from the village of Sedayu Lawas, east of Tuban in East Java, and the Bawean islands in the Java Sea. They vary in hull form and decoration. Some are similar to *kacik* but not as finely decorated. As on the *kacik*, the rudder of the *cemplok* depends from one of two pegs, just off centre, port and starboard, on a strongly reinforced frame at the aft end of the deck-house (Fig. 21). When deployed the rudder stock fits into one of the deep notches, port and starboard, in a beam at the after end of a platform built over the stern.

Konteng type

Konteng are large fishing vessels, and *ijon ijon* are slightly smaller fishing craft, built at the villages of Blimbing and Brondong to the east of Tuban in East Java. Some of the oldest boatbuilders of the area are said to have come from the north coast of Madura and both *konteng* and *ijon ijon* look like now-extinct types of Madura *perahu*.

The *konteng* rudder depends from a pole that is stepped through two thwarts, one above the other, which are some way forward of the sternpost (Fig. 22). The ends of these beams project slightly outboard, suggesting that they are vestigial rudder-mounting beams, but the rudder stock does not bear against the aft face of either of these beams, instead it fits into a notch in a projecting rail timber running after from the beams. *Ijon ijon* have the same rudder mounting.

Typically these vessels are built entirely from teak (*Tectona grandis*); and the rudder of a *konteng* in the collection of the Museum of Arts and Sciences, Darwin, Australia, is teak. With the

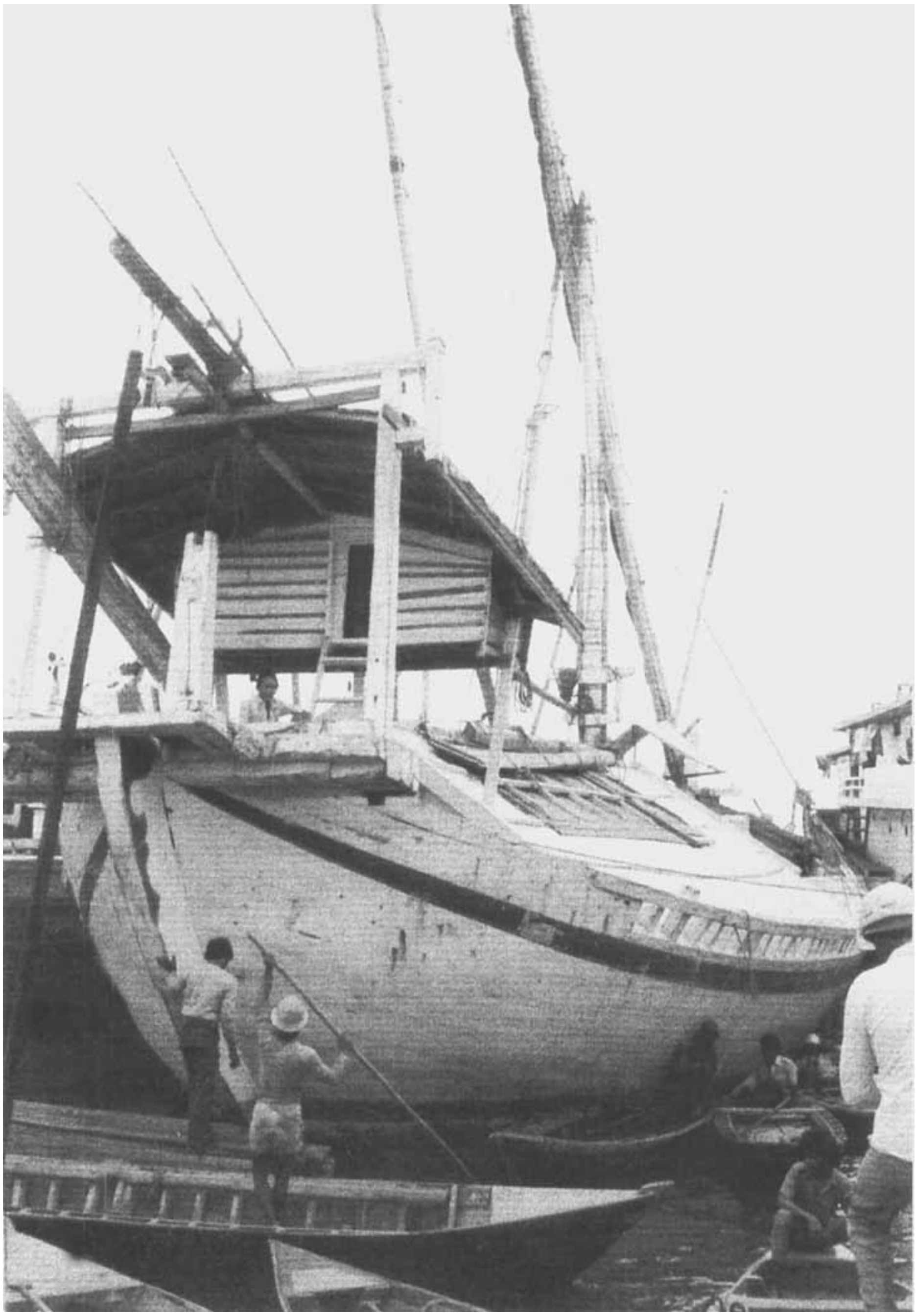

Figure 18. A *lete lete* from Raas or Sapudi with a very unusual cabin. This large vessel, which might sail deep laden with no freeboard midships, has the *lete lete*-type rudder mounting, rather than the palari-pinis type. The rudder is lying on the gabled hatch-cover/roof with its heel towards the viewer. (Photo: Ian Trantham)

lower lashing released the rudder would float up to equilibrium buoyancy at a greater angle of rake.

Kolek type

Kolek are *mayang* fishing craft now built and used mainly in West Java, but originally from Central Java. As noted above, the *kolek* uses a removable piece (*mangga mangga*) which projects outboard and obliquely aft on the side the rudder is being carried, from the beams through which the rudder mounting post steps (Fig. 23). *Kolek*, like *konteng*, have two beams one above the other. The inboard end of the *mangga mangga* jams between the

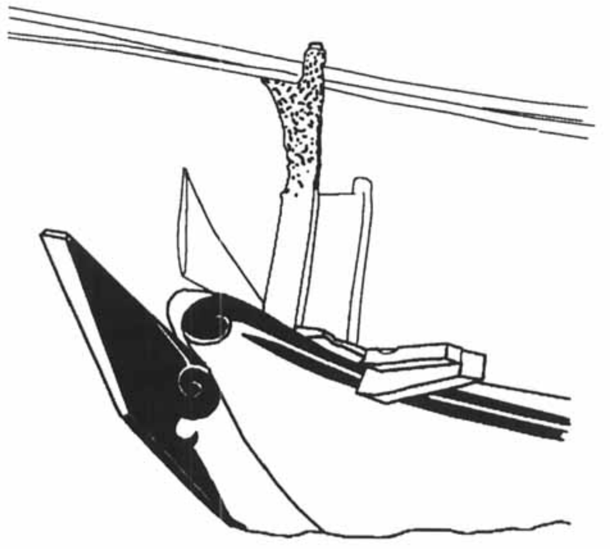

Figure 19. The stern of a *perahu golekan.* The rudder is on deck and the heel of the rudder is pointing towards the viewer. (Drawing: author)

two beams and butts against the rudder mounting post. It is not meant to take a great loading. There is no special fitting where the rudder bears against the rail. The rudder of a shallow-drafted *mayang* fishing vessel is unstropped from the rudder mounting post and used nearer horizontal as a sweep for steering when in shallow water.

Non-pintle and gudgeon median rudders

Perahu lambo, the most common trading *perahu* of Eastern Indonesia, is a type which shows considerable western influence in its design (Figs 24 & 25), though it can be argued that the basic hull form is indigenous (Burningham, 1989: 191). The *perahu lambo* is typically a gunter or gaff rigged sloop or ketch with a long counter stern. The majority of *perahu lambo* have the rudder hung on the sternpost using a steel pintle and gudgeon. The rudder stock passes through the stern inside a hollowed out trunk. In nearly all *lambo*, the bottom of the rudder trunk (the point where the sternpost enters the hull and the counter begins) is below the light laden waterline. The whole rudder blade and part of the stock are always immersed.

The rudder, made from very dense timber, would sink if it became dismounted from the gudgeons, so, like all Indonesian quarter-rudders, it hangs from a structure built over the stern (Fig. 24). The lanyard which hangs the rudder is always kept taut to relieve wear on the pintle and gudgeon. Some *lambo* have lashings through small holes in the rudder and the sternpost instead of metal pintle and gudgeon. Others, particularly auxiliaries, have the heel of the rudder slotted into a round hole in the aft end of the keel—a system that appears to be quite satisfactory (Fig. 25). The same system was used on more traditional Sulu Sea vessels such as the 'Sea Gipsy' *lipa lipa* (Burningham, 1993: 201).

Tiller configurations

Eastern Indonesian quarter-rudder tillers usually point aft. Sometimes they also angle inboard so that the helmsman does not have to lean outboard. *Perahu pinis* tillers typically angle upwards. Some outrigger canoes with the rudder-mounting beam right aft have forward-pointing tillers. They usually have the 'Y'-type upper mounting, and the lever that tightens the rudder lashing has to be positioned outboard so that it does not foul the tiller.

The double-ended *soppe* of the Bajo are sometimes steered with a median rudder mounted on the sternpost (or where the sternpost would be if they had one). The tiller projects thwartships from the rudder stock—perpendicular to the rudder blade—and it projects to leeward. When the *soppe* changes tack, the tiller is shifted to the leeward side of the rudder. It is controlled with a lanyard led forward. These boomed lateen-rigged *soppe* have considerable weather helm. The *soppe* helmsperson only needs to counter the weather helm by pulling on the lanyard to steer. To turn downwind, they pull harder; to turn upwind, they relax the pull on the lanyard a little. The Bali *jukung*'s tiller points forward. Java and Madura vessels' tillers point forward. They are often quite short.

The Javanese *Jong*

When European ships first reached Southeast Asia, large Southeast Asian merchant ships were as big as large European ships. Manguin (1993: 198) calculates an average of 350 to 500 tonnes burden for a fleet of large *jong* which sailed from Jepara Java in 1512. No known iconography records the appearance of the very large *jong*, but medium-sized vessels are regularly recorded with a consistent appearance (Fig. 26). They appear to

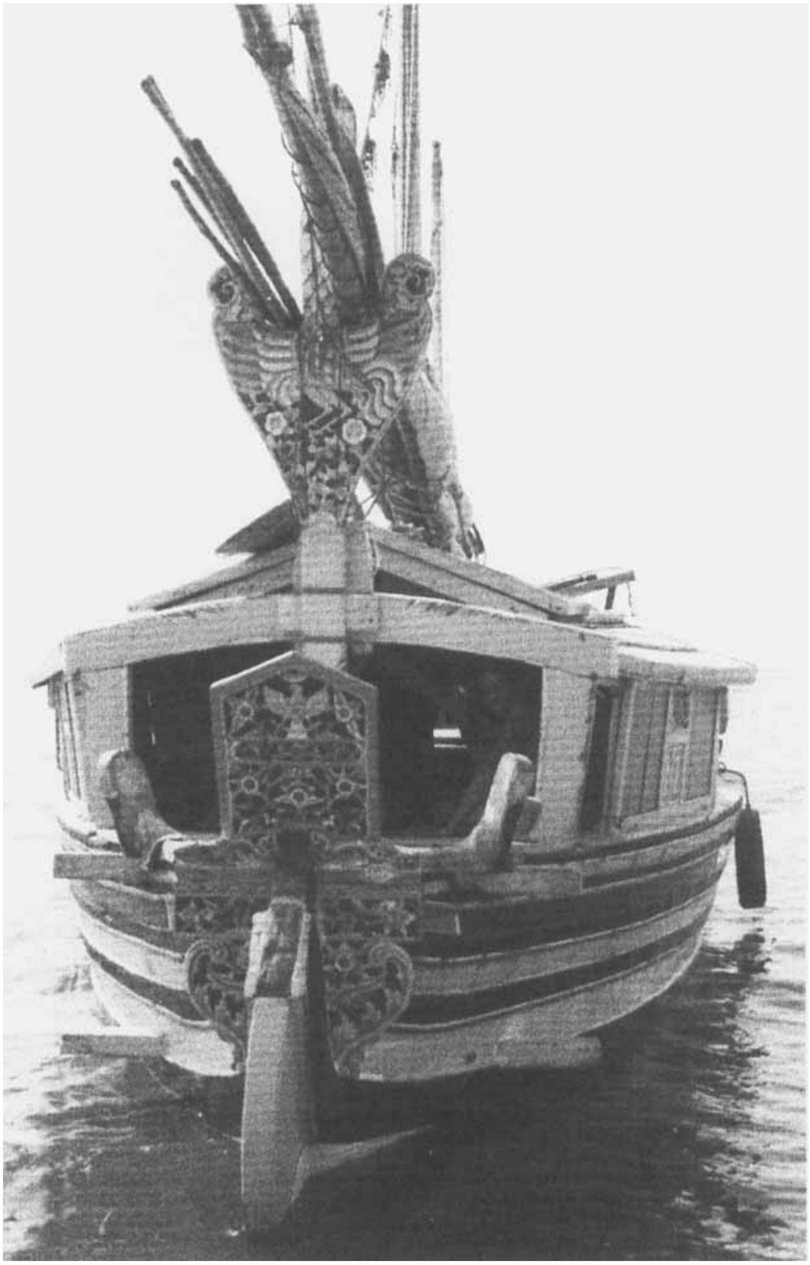

Figure 20. The stern of a small *perahu kacik*, rudder not in place. (Photo: Kurt Stenross)

have had double quarter-rudders like Sulawesi *perahu pinis*. Detail of the rudder mountings is not shown, but there is some reason to postulate that they might have used the system called 'braced mounting' in Mott (1997: 21). In this arrangement the rudder stock bears on the after face of the lower mounting beam, and the *forward* face of the upper beam. The reason for proposing this is what appear to be vestigial rudder mounting beams projecting from the hulls of *kacik, konteng* and *kolek. Konteng* and *kolek* can be regarded as the most conservatively designed Javanese *perahu mayang* (Burningham & Stenross, 1994: 131). The lower beam is usually somewhat forward of the upper one. If a rudder was mounted in the Sulawesi manner—on the after faces of both beams—it would rake forward which is an unsatisfactory arrangement. If, however, the rudder bore on the forward face of the upper beam a satisfactory rake would be achieved.

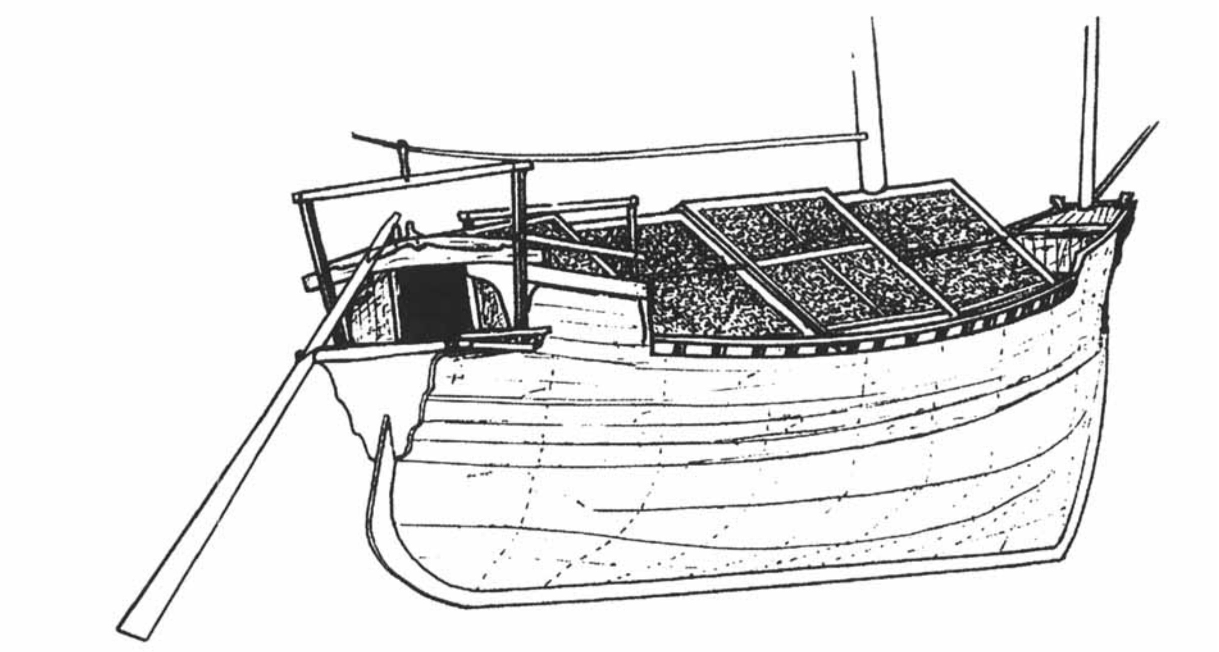

Figure 21. A *perahu cemplok* from Sedayu Lawas. (Drawing: author)

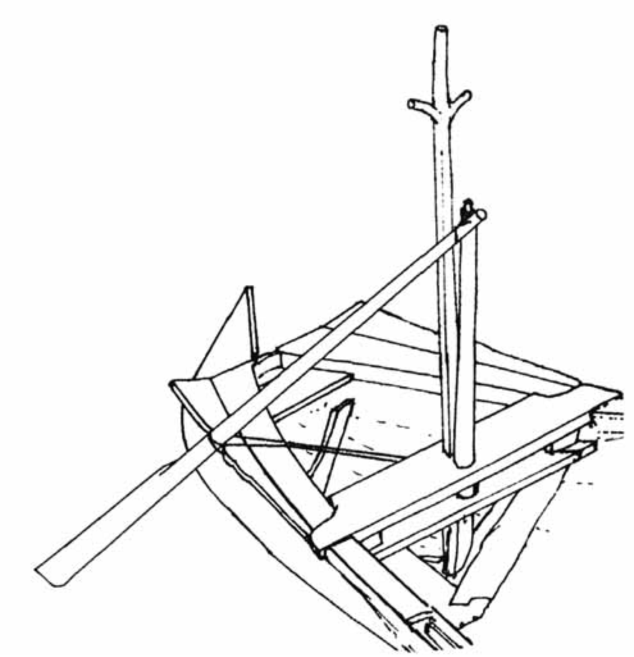

Figure 22. Rudder mounting of a *perahu konteng*. (Drawing: author)

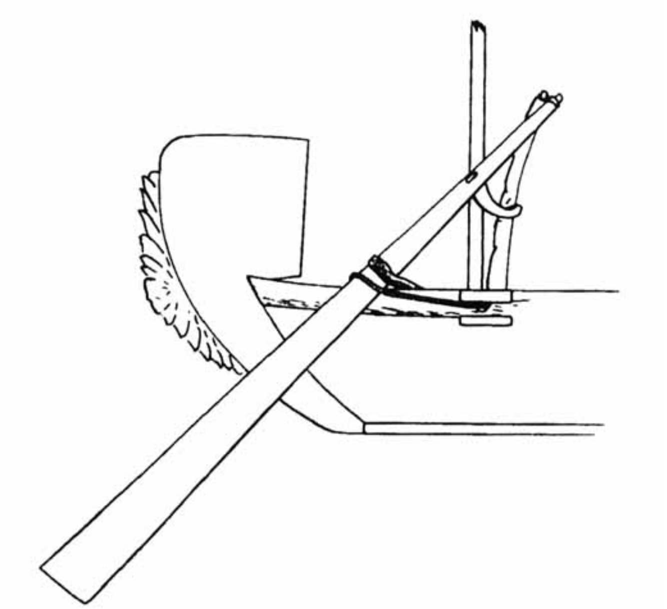

Figure 23. Rudder mounting of a *kolek* with the *mangga mangga* projecting. (Drawing: author)

Discussion

Ethno-archaeological parallels must always be used with caution, but can be enlightening. All Indonesian rudders hang from a strong strop at their top end. Most use an ingenious system for tightening the lashing at the lower point of attachment. There is no evidence for or against Classical or Medieval Mediterranean rudders being similarly suspended, but, by assuming that they are not, Mott imposed a buoyancy problem where the rudder would be likely to slide downwards in its mountings, or try to pivot downwards into the

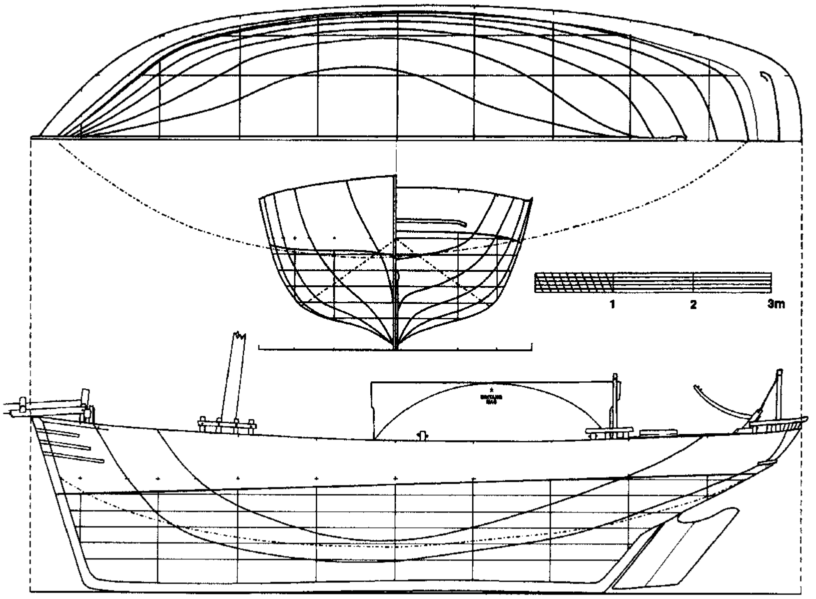

Figure 24. Lines of a small *perahu lambo, 'Bintang Mas'* from Bonerate. The median rudder hangs from a frame in the stern. (Drawing: author)

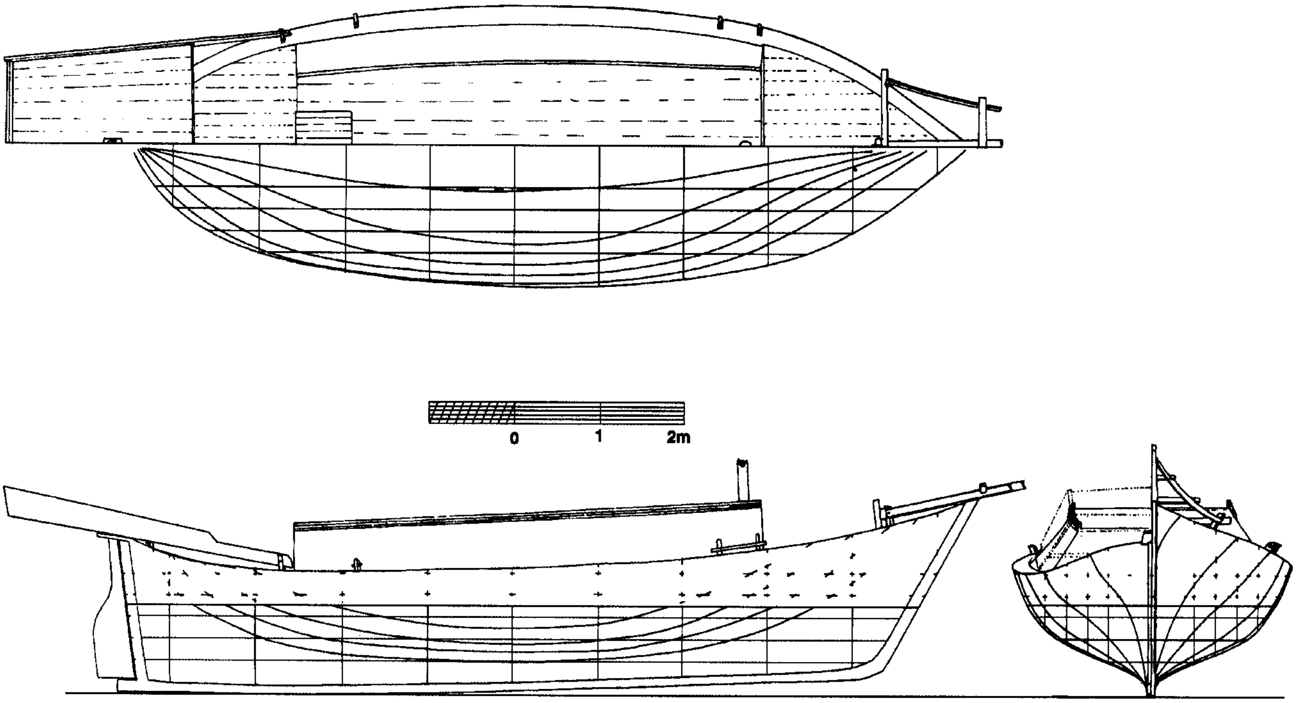

Figure 25. Lines of a *lambo-soppe, 'Wantoramata III'* from Kaledupa. The heel of the rudder has a pin which fits into a hole in the aft end of the keel. Similar *lambo-soppe* or *perahu sande* were fitted with quarter-rudders. (Drawing: author)

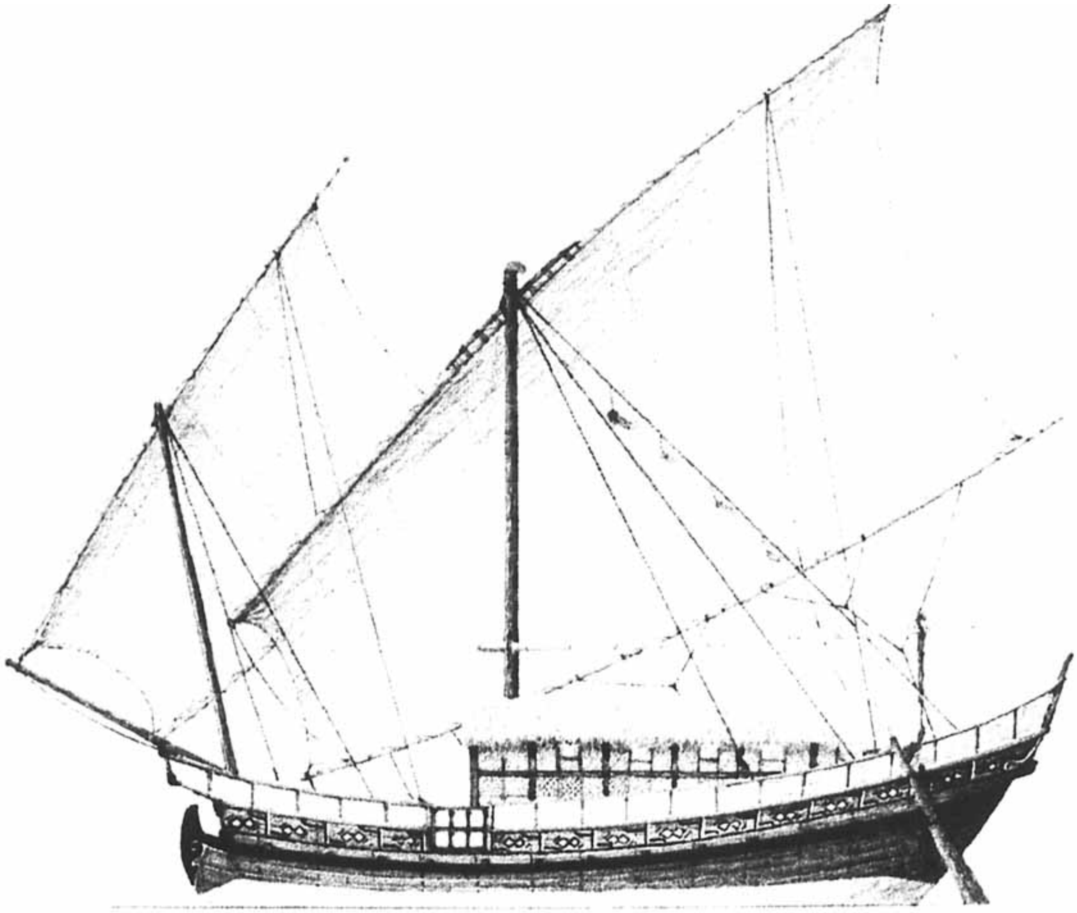

Figure 26. Reconstruction of a 16th-century Javanese *jong*. (Drawing: author)

water until it reached equilibrium buoyancy if not sufficiently immersed; conversely it would move upwards if too deeply immersed when the vessel was deep laden, he argued.

Mott (1997: 18) proposed that:

> any quarter-rudder mounting system had to satisfy three conditions: [1] it had to hold the rudder firmly at two points, or along a section of the shaft; [2] it had to permit the rudder to be moved in the mount up or down in a direction parallel to the shaft; and [3] it had to allow the rudder to be removed for maintenance.

Most Indonesian systems satisfy the first condition, but in many cases it is a dynamic system designed to create loads pushing the rudder against the hull and avoid forces splaying the rudder away from the hull against which the rudder is less firmly restrained.

The third requirement is satisfied by all Indonesian systems, but the second requirement is satisfied by none. Mott proposed the second requirement, that quarter-rudders needed to be moved up or down in order to achieve approximate equilibrium buoyancy and, on the basis of this requirement, Mott inferred the existence of mechanisms to move the rudders up and down without direct evidence for such mechanisms. But this does not seem to have been a necessary solution to a real problem. In comparison with the hydrodynamic forces acting on the rudder due to lift and drag on the blade, when sailing at any reasonable speed, those flotation and gravity-induced forces are slight, and there is no need to adjust the rudder immersion to reduce those small forces.

Except for the palari-pinis mounting, no Indonesian rudder mounting system has any mechanism to alter the degree of rudder immersion when in use for steering. The palari-pinis rudder is probably never deployed at equilibrium buoyancy because it is usually made from timber that does not float. The palari-pinis mounting is used on the largest craft because of its convenience, but other mountings are used on vessels of up to about 100 tonnes deadweight capacity, and perhaps more. And some of these vessels, particularly *lete lete* and *janggolan*, sail very deep laden and also sail empty without ballast causing great changes in the degree of rudder immersion.

Since extant quarter-rudders have no mechanism for moving the deployed rudder up and down, it is possible that there was no mechanism for moving most Classical and Medieval quarter-rudders up and down either.

Notes

[1] For a description of the *janggolan* rig which has been modified to allow tacking, and other aspects of these vessels, see Burningham and Mellefont (1997).

[2] The same adoption of Sulawesi-type rudders has recently been seen on other types of Madurese perahu of more than about 100 cu. m capacity.

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